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Indian Standard

PERFORMANCE TESTING OF POWERED INDUSTRIAL TRUCKS WORKING IN HAZARDOUS AREAS

PART I INTERNAL COMBUSTION ENGINE POWERED

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PART I INTERNAL COMBUSTION ENGINE POWERED

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Indian Standard

PERFORMANCE TESTING OF POWERED INDUSTRIAL TRUCKS WORKING IN HAZARDOUS AREAS

PART I INTERNAL COMBUSTION ENGINE POWERED

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 31 January 1979, after the draft finalized by the Industrial Trucks Sectional Committee had been approved by the Marine, Cargo Movement and Packaging Division Council.

0.2 Safety in industrial operations is of extreme importance in order to avoid loss of human life or equipment and as incentive to the workmen involved in these operations. As more and more industrial trucks are utilized for load movement in potentially hazardous atmosphere in most of the growth industries, there is absolutely a need for unequivocal guidelines on the economization of the risks involved, not only in the design and manufacture and conversion of trucks, but also their operation, maintenance and testing. It may be difficult to make all areas absolutely free of hazardous atmosphere and may be more economical to devise means to ensure a safe operation for the industrial trucks in hazardous atmospheres.

0.3 The performance of such special design features as are provided to ensure the above requirements, is as important as taking care to maintain these special features. Thus, testing plays an important role before the truck can be put in operation. This standard on performance testing has been drawn up to fulfil that need.

0.4 Industrial trucks may be powered with an electric battery or internal combustion engine. As such this standard is issued in the following two parts:

Part I Internal combustion engine powered, and

Part II Electric battery powered.

This standard (Part I) is complimentary to IS: 8790 (Part I)-1978*.

0.5 For performance testing of engines for internal combustion engine-powered trucks, reference may be made to IS : 1601-1960†.

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*General requirements of powered industrial trucks working in hazardous areas: Part I Internal combustion engines — powered trucks.

†Performance of constant speed internal combustion engine for general purposes.

0.6 In the preparation of this standard, assistance has been derived from ANSI B56.4-1972 'Standard for safety — Industrial trucks, internal combustion engine-powered', issued by the American National Standards Institute (ANSI).

1. SCOPE

1.1 This standard (Part I) covers the tests to check the performance of internal combustion engine-powered industrial trucks designed to operate in hazardous areas.

2. PERFORMANCE TESTING FOR TRUCKS — ALL TYPES

2.1 Temperature Tests

2.1.1 *General*

2.1.1.1 The materials employed in the construction of an industrial truck shall not be damaged by the temperatures attained during normal operation under the conditions of maximum rated load and under conditions of maximum overload maintained for a short period of time. The maximum temperature rise on the surface of any combustible material or electrical insulation shall not exceed 150°C; the maximum temperature rise of gasoline or diesel fuel in a fuel tank shall not exceed 50°C. The test period shall be that required to establish equilibrium conditions for temperature rise and pressure determinations, but shall be continued for not less than 2 hours; except that a tractor shall be operated for an additional 1-minute period against a bumping post or other obstruction, thereby causing the wheels to slip and the tractor to exert maximum drawbar pull in effect.

2.1.1.2 Compliance of a truck with the requirements of **2.1.1.1** shall be determined by operating it under the conditions of operation as defined in the following clauses for the specific types of trucks indicated.

2.1.1.3 Test courses shall be smoothly paved with asphalt, concrete, or brick. A wood flooring may be employed for ramps or other portions of the test course.

2.1.1.4 Tests shall be conducted indoors or in a covered area protected against the direct rays of the sun. Wind velocity in the test area shall not exceed an average of 25 km/h. The temperature of the ambient air shall be not below 20°C nor more than 40°C, and shall not vary more than 6°C between maximum and minimum throughout the period of the test.

2.1.1.5 Operating temperatures measured at any one time shall be related to ambient temperature of the air at the same time and location.

2.1.2 *Fork and Platform Trucks* — The test course shall be 60 m long, including a grade equal to manufacturer's specified grade for the truck over a length not less than 10 m. The truck shall be operated over this course hauling full rated load. At the end of the course, the truck shall be turned at right angles, the load raised to full height, and then lowered to the hauling position. The truck with the load is then to return to the starting point, where the load shall again be raised and lowered and deposited at right angles to the test course. The truck shall then be operated with no load over the same course and, at the end of the course, the forks or platform be raised to full height and lowered. The truck shall then be returned to the starting position, where the load is to be picked up. These runs shall then be repeated, alternating between loaded and unloaded trips. The vehicle is to travel at the maximum safe practical speed.

2.1.3 *Load-Carrying Trucks* — The test course may be of any convenient length over 60 m. If the length exceeds 90 m, the truck is to be stopped and started at intervals of approximately 60 m. The course shall contain a grade of not less than 10 percent, with a total rise of not less than 1·2 m. It shall be negotiated not less than six times per hour. The truck shall carry its rated load. The test shall be conducted in such a manner that the truck is in motion approximately 80 percent of the time.

2.2 Fuel-Consumption Tests

2.2.1 The rate of fuel consumption, based on a two-hour test period of operation under the conditions of maximum overload for a short period of time, shall be such that the fuel supply for a Type GS or DS truck will be sufficient for an eight-hour period of similar operation.

2.2.2 The fuel tank or container shall be filled to capacity prior to the start of each test. The fuel tank for a Type GS or DS truck shall be again filled to capacity at the end of the test period and the amount required for this purpose shall be accurately measured, and the fuel depletion for an eight-hour period shall be calculated. The appropriate test courses described for the Temperature Test shall be used for conducting fuel-consumption tests.

2.3 Backfire-Deflector Tests

2.3.1 A backfire deflector under backfire conditions shall contain a visible flame front within its confines, and shall not be displaced physically damaged or distorted, or show evidence of burning or smouldering of internal parts; and, if of the oil-bath type, shall be free of any overflow or discharge permitting accumulation of oil on electrical, hot-engine or exhaust-system parts.

2.3.2 A complete industrial truck shall be used for this test. In lieu of tests, a backfire deflector designed for the equivalent displacement gasoline engine is required for a diesel engine.

2.3.3 The backfire deflector (air cleaner, oil-bath or dry-element type) and connecting hose shall be removed from the engine. The spark timings shall be advanced (approximately eight degrees) and the spark-plug leads shall be interchanged to obtain sharp backfires under the following conditions. The engine shall be alternately raced and idled, and the ignition switch shall be operated to alternately energize and de-energize the ignition system. During this test, the intensity of the backfire and the issuance and extent of the accompanying flame shall be noted.

2.3.4 The backfire deflector (air cleaner) shall then be installed on the truck in the intended location. An oil-bath type deflector (air cleaner) shall be filled to the marked 'full-level line' of the bowl. Paper is to be placed beneath the intake orifices of an oil-bath type and over adjacent surfaces of parts likely to be affected by accumulations of oil.

2.3.5 The engine shall then be operated in the several manners determined in the preliminary test to provide for the most severe backfire conditions. At least ten and not more than twenty severe backfires are to be produced.

2.3.6 Observations for containment of flame shall be made under semidarkened conditions by at least two observers. No visible flame shall be in evidence at any time during the tests. In the tests of an oil-bath type, paper shall not show evidence of oil deposits in the form of droplets.

2.3.7 A dry-type filter element shall be tested in the above manner, then removed, and then subjected to five consecutive washing and drying cycles. Washing shall consist of immersion in plain water together with sufficient agitation to remove bulk material adhering to the outside surface. This test element shall then be remounted as intended in normal operation, and the backfire test shall be repeated.

2.3.8 The side of the filter media normally exposed to backfire shall then be subjected to a flame source of sufficient intensity to cause the media to burn or glow. The flame source shall then be removed and an acceptable filter media is not to continue to burn or smoulder.

2.4 Muffler Tests — Types G, D, and LP

2.4.1 The muffler for Types G, D, and LP industrial trucks shall not rupture under conditions of backfire.

2.4.2 A complete industrial truck shall be used for this test. In lieu of tests, a muffler designed for the equivalent displacement petrol engine is required for a diesel engine.

2.4.3 A spark plug shall be installed in the exhaust manifold and connected to a spark coil which can be energized from a battery through a momentary-contact switch.

2.4.4 The engine shall be continuously operated until the truck is in a heated state. This state may be assumed to have been reached when the exhaust manifold has been heated to approximately 315°C. Twenty-five severe backfires are to be obtained by alternately racing and idling the engine, with spark retarded, and momentarily energizing the auxiliary spark plug in the exhaust manifold. In addition, the ignition switch shall be operated so as to alternately energize and de-energize the ignition system.

2.5 Exhaust-System Tests — Types GS, DS, and LPS

2.5.1 *General*

2.5.1.1 The exhaust system for Types GS, DS, and LPS industrial trucks, including the muffler and any tailpipe, shall not rupture and shall prevent the omission of flame and/or sparks so as to cause charring smouldering, or ignition of unmilled cotton waste under conditions of backfire with and without the introduction of spark-producing material into the exhaust system.

2.5.1.2 A complete industrial truck shall be used for this test. In lieu of tests, an exhaust system designed for the equivalent displacement petrol engine is required for a diesel engine.

2.5.1.3 A spark plug shall be installed in the exhaust manifold and connected to a spark coil which can be energized from a battery through a momentary-contact switch.

2.5.1.4 Targets shall be constructed by hand packing unmilled cotton waste into a wooden frame two feet square and four inches deep. The frame shall be backed by expanded metal with the cotton held in place by poultry netting over the front. This standard target shall be modified during the test programme by placing sheet metal against the rear surface and burlap over the front.

2.5.2 *Backfire*

2.5.2.1 The tailpipe assembly shall be removed prior to starting the series of tests.

2.5.2.2 The engine shall be continuously operated until the truck is in a heated state. This state may be assumed to have been reached when the exhaust manifold has been heated to approximately 315°C. Repeated backfires are to be obtained by alternately racing and idling, the engine, with spark retarded, and momentarily energizing the auxiliary spark plug in the exhaust manifold. In addition, the ignition switch shall be operated so as to alternately energize and de-energize the ignition system. During this test, the intensity of the backfire and the issuance and extent of the accompanying flame shall be noted (*see* **2.3.6**).

2.5.2.3 The tailpipe assembly shall then be reinstalled and the above tests shall be repeated. The intensity of the backfire and the extent, length, colour, and direction of any flame front shall be noted.

2.5.2.4 A series of tests shall then be conducted using both types of targets positioned flush against the exterior surface of the truck at the location affected to the greatest degree by the direction of the exhaust immediately at the tailpipe exit and up to 150 mm from the exit. A single test shall consist of a minimum of 10 and a maximum of 20 severe backfires.

2.5.2.5 The targets shall be removed briefly from the test areas throughout the test series and examined from evidence of burning or smouldering particles.

3. PERFORMANCE TESTS FOR AUTOMOTIVE TYPE COMPONENTS

3.1 Vibration Tests

3.1.1 *Electric Fuel Pumps* — An electric fuel pump shall be capable of delivering the manufacturer's rated fuel delivery, at the manufacturer's specified discharge pressure and fuel lift, when operating at plus or minus 10 percent of the rated voltage, both before and after being subjected to 48 hours of vertical displacement of an amplitude of 5 mm at the frequency which produces maximum resonance. During the test, the assembly of the pump and its mounting means shall not be loosened or otherwise damaged.

3.1.2 *Mechanical Disconnect Switches* — A mechanical disconnect switch shall be capable of maintaining a closed circuit and shall not become loosened from its mounting, be otherwise damaged, or become inoperable, when subjected to 8 hours of displacement of an amplitude of 5 mm from its most vulnerable mounting position, at the frequency which produces maximum resonance.

3.1.3 *Fuel Filters* — A fuel filter shall not become loosened from its mounting or be otherwise damaged when subjected to 48 hours of vertical displacement of an amplitude of 5 mm from its normal mounting position of the frequency which produces maximum resonance.

3.1.4 *Test Method*

3.1.4.1 For these tests, amplitude is defined as a maximum displacement of sinusoidal motion from position of rest or one-half of the total table displacement. Resonance is defined as a maximum magnification of the applied vibration.

3.1.4.2 A representative sample of the component shall be mounted using its own bracket if provided, otherwise in a standard mounting fixture, and secured to the test fixture of the vibration test apparatus in the same upright or horizontal position which it occupies when in use.

3.1.4.3 An electric fuel pump shall be tested both before and after the vibration test, under the conditions described in **3.1.1**, to determine its capacity for rating purposes.

3.1.4.4 A mechanical disconnect switch shall be wired into a circuit with an indicator light, and with the switch contacts closed during the test, to provide a visual means of observing the maintenance of a closed circuit.

3.1.4.5 The test specimen shall then be subjected to variable frequency and endurance tests with a vertical displacement of an amplitude of 5 mm.

3.1.4.6 The test specimen shall be vibrated from 10 cycles per second to 20 cycles per second in discrete frequency intervals of 2 cycles per second. The vibration at each frequency shall be maintained for 5 minutes.

3.1.4.7 The test specimen shall then be vibrated for the specified period at the frequency which produces maximum resonance as determined in the variable frequency test or, if no resonance is observed in the variable frequency test, at a frequency of 17 cycles per second.

3.2 Endurance Tests

3.2.1 *Electric Fuel Pumps*

3.2.1.1 An electric fuel pump shall be capable of delivering its rated output without overheating or evidence of damage when continuously operated for a period of 800 hours.

3.2.1.2 The pump shall be mounted in its normal position and be connected to exert a constant suction lift established at the maximum recommended by the manufacturer. During the test, the discharge pressure shall be varied within the range recommended by the manufacturer, but in manner to provide operation for 400 hours at the maximum discharge pressure and at the manufacturer's rated voltage.

3.2.1.3 At other periods throughout the test, the impressed voltage shall be varied between 90 and 110 percent of the manufacturer's rated voltage.

3.2.2 *Mechanical Disconnect Switches* — A mechanical disconnect switch shall be capable of opening and closing a 40-ampere, 6-volt direct-current load across the battery disconnect contacts and a 5-ampere load across the field contacts, if furnished, throughout 4000 cycles of operation, where each cycle of operation consists of one second with contact closed and 5 seconds with contacts open.

3.2.3 *Fill and Vent Fittings*

3.2.3.1 A self-closing fill and vent fitting shall, following 100 000 cycles of opening and closing of the cap, (a) prevent the build-up of a negative pressure in a fuel tank in excess of 10 kPa, gauge; (b) prevent venting up to a pressure of 10 kPa, gauge; and (c) prevent the build-up of a positive pressure within the range of 25 kPa to 35 kPa gauge.

3.2.3.2 At least two samples of each style and size of fittings shall be mounted to a cycling machine and subjected to continuous operation. One cycle is considered to be one opening and closing of the cap operated through the full travel limits of its attachment arm.

3.2.3.3 Following 100 000 cycles of operation, the samples shall be mounted on a simulated fuel tank fitted with a combination pressure-vacuum gauge having ranges exceeding the above values by at least 50 percent. The tank shall be gradually subjected to air pressure and then gradually to a vacuum, and observations made of the positive and negative air pressures associated with the operation of the fitting. The start-to-discharge pressure of the fill-cap assembly shall be observed by immersing the assembly in water or by employing a soap and water solution to the vent outlet.

3.2.4 *Dielectric Withstand Tests* — An electric fuel-pump assembly and a mechanical-disconnect switch shall withstand for one minute, without breakdown, the application of a 50 Hz alternating potential of 500 volts between live parts and dead-metal parts.

3.2.5 *Mercurous Nitrate Immersion Tests*

3.2.5.1 Fuel-confining brass parts made of a copper alloy containing more than 15 percent zinc shall withstand total immersion, for 15 minutes without cracking, in an aqueous mercurous nitrate solution containing 100 g of mercurous nitrate and 13 cm^3 of nitric acid (specific gravity 1·42) per litre of solution.

3.2.5.2 A test sample shall be subjected to the physical stresses normally imposed on or within a part as the result of assembly with other components or with tubing or piping. Such stresses shall be applied to the sample prior to and be effective during the test.

3.2.5.3 Female pipe-threaded ends shall be engaged with brass plugs or fittings tightened to the degree normally found acceptable to produce a leaktight assembly.

3.2.6 *Hydrostatic Strength Tests*

3.2.6.1 An enclosure for an electric fuel pump shall be capable of withstanding, without rupture or distortion, a hydrostatic pressure of five times the maximum pressure recorded during the explosion test.

3.2.6.2 The samples of pumps previously subjected to the explosion test shall be connected to a source of hydrostatic pressure. A positive shut-off valve and a pressure gauge having a pressure range of not less than one and one-half times nor more than two times the test pressure shall be installed in the hydrostatic pressure-supplying piping. The pressure gauge shall be installed in the piping between the shut-off valve and the pump enclosure under test.